MEE427 PID CONTROL ASSIGNMENT # 1

1) Time Response Simulation

Consider the simple feedback loop, as seen in Figure 1, with disturbance *d* and the noise *n* are *zero*.

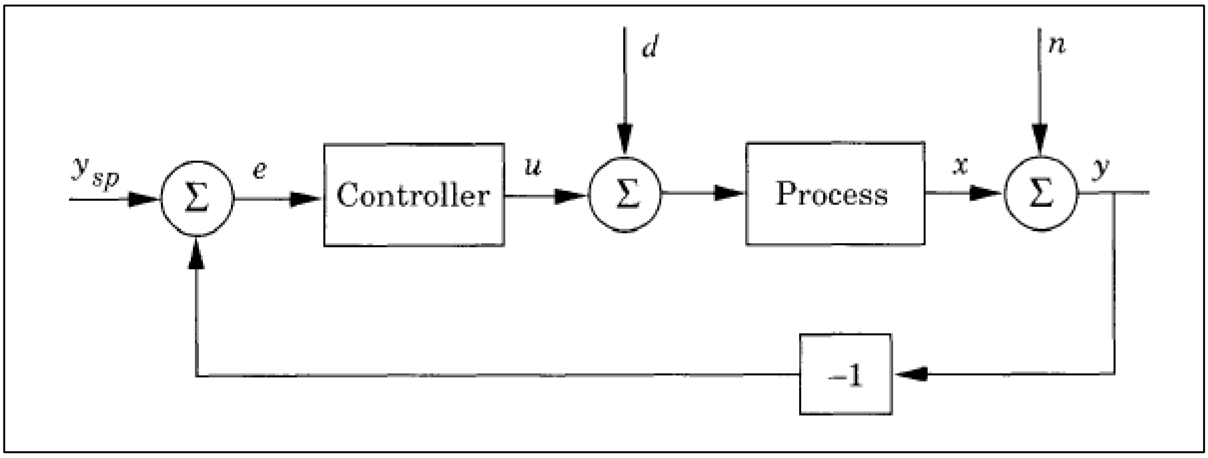

Figure 1: *Simple feedback loop*

The process block is given in Equation 1. The controller is considered as proportional action.

$$G(s) = \frac{1}{(s+1)^3} \tag{1}$$

- Simulate the system with a unit step change in the set point (y_{sp}) with different proportional gain K_p ($K_p = 1$, $K_p = 2$, $K_p = 5$) by using any simulation program (Matlab/Simulink, Python etc.) and demonstrate the process output (y) and control signal (u) plots. Eventually, you should reach the responses in time domain as given in Figure 2a and 2b.

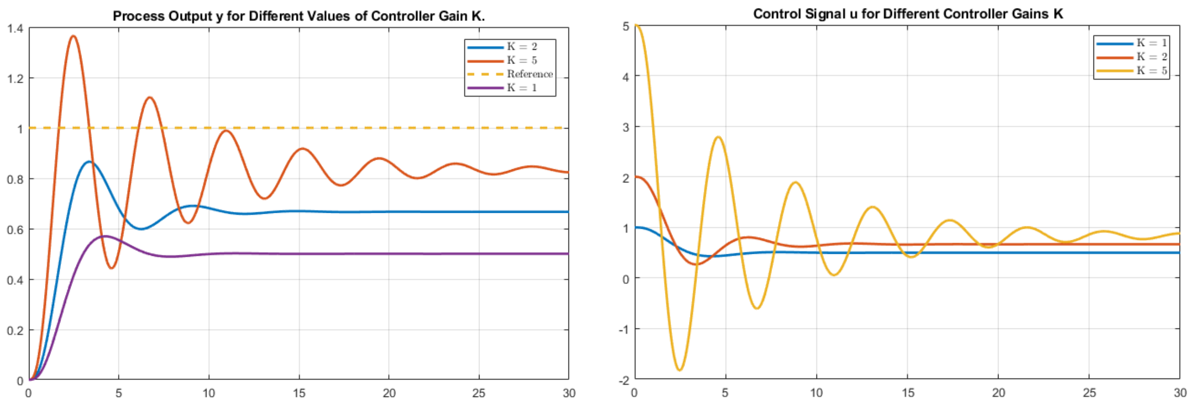

Figure 2: a) *Process output for different K gains* ***b)*** *Control signal for different K gains*

- For further works, the simulation to be compatible to PI controller implementation as well.
- Bring all the necessary codes, models and figures to laboratory course to investigate the process thoroughly.

2) Frequency Response Simulation

The controller transfer function can be represented as shown in Equation 2 using control parameters (proportional gain K_p, integral time T_i and derivative time T_d).

$$C(s) = K_p\left(1 + \frac{1}{sT_i} + sT_d\right) \tag{2}$$

This kind of controller is called non-interacting form and its block expression is given in Figure 3.

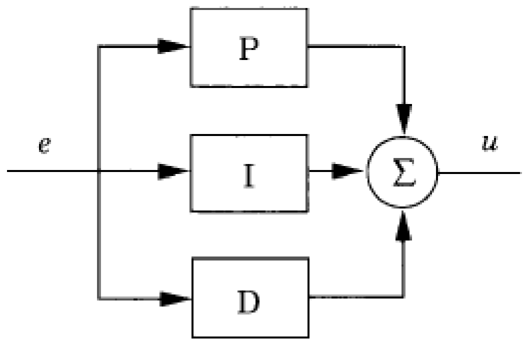

Figure 3: *Non-interacting form*

The interacting form is represented as in Equation 3, where the derivative time T_d' influence the integral part and the block representation is given in Figure 4.

$$C'(s) = K_p'\left(1 + \frac{1}{sT'_i} + sT'_d\right) \tag{3}$$

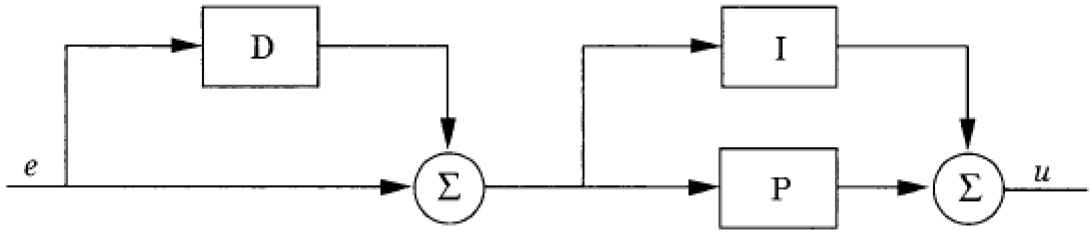

Figure 4: *Interacting form*

The interacting form controller ($C'(s)$) can always be represented as a non-interacting form controller whose coefficients are given by

$$\begin{aligned} K_p &= K_p' \frac{T'_i + T'_d}{T'_i} \\ T_i &= T'_i + T'_d \\ T_d &= \frac{T'_i T'_d}{T'_i + T'_d} \end{aligned} \tag{4}$$

- Define a first order plant with a specific *p* value as in the transfer function given in Equation 5.

$$G(s) = \frac{K}{s+p} \tag{5}$$

- Draw the frequency response diagram of the specified plant by using any simulation program (Matlab/Simulink, Python etc.).
- Draw the frequency response of PID controller with the interacting by using parameters below.
- Draw the frequency response of controlled system (PID controller and given plant) so that simulation of the overall cascade system can be shown.
- Calculate the non-interacting PID controller parameters by using Equation 4, then draw the frequency response diagram by using the non-interacting form PID controller. Compare these two results.
- Bring all the necessary codes, models and figures to laboratory course to investigate the process thoroughly.

<u>Parameters given;</u>

$$p = 10$$

$$K = 1$$

$$K_p = 6$$

$$T_i = 4$$

$$T_d = 1$$